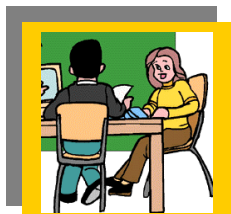


## Cosmic Chemistry: Planetary Diversity

## Stochastic Processes: Out of Chaos

### STUDENT ACTIVITY



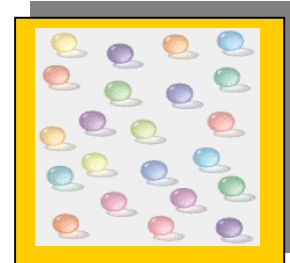
You will work on this assignment grouped in pairs. One student in each group should randomly withdraw the marbles and the other group member should record the results in the DATA TABLES that are found in the "Student Reporting/Data Sheet." Both students in the group should cooperate in making the required calculations.

### PART 1

The goal of this part of the activity is to observe how the relationship between predicted and observed outcomes of random chance events are related to the number of observations made.

### INSTRUCTIONS

1. Obtain a sample of fifty (50) marbles each of three different colors from your instructor.
2. Complete DATA TABLE #1 by indicating the color of each of the three sets of marbles.
3. Place the 150 marbles into a wide-mouth container (such as a mixing bowl) and mix them thoroughly.
4. Discuss various methods for obtaining random samples of the marbles in the container, and agree upon one to be used in this activity with your partner.
5. Using the method you agreed upon, withdraw ONE marble from the container and record its color on the "Trial #1" line of DATA TABLE #2. Put the marble back into the container and mix all of the marbles again.
6. Repeat Step 5 until a total of ten (10) observations have been made, recording each marble color on the appropriate line of DATA TABLE #2.
7. Count the number of times you drew each color of marble in DATA TABLE #2 and record this number at the bottom of the "Color of Marble" column for Trial #1 - #10.
8. Repeat Steps 5, 6, and 7 four more times, until a total of three observation sets of ten trials each have been made, recording the results and calculating the totals in the appropriate lines and columns of DATA TABLE #2.
9. Copy the sums from your three sets of trials in DATA TABLE #2 into the appropriate line of DATA TABLE #3 in the "Your Data" section.
10. Sum the values for each marble color that you have recorded in DATA TABLE #3, and record these in the "Total Trial #1-#30" column in the "Your Data" section.
11. Complete DATA TABLE #3 by entering the Trial #1-10", "Trial #11-20", "Trial 21- 30", and "Total" data obtained by two other groups of classmates.



12. Sum the "Total values in DATA TABLE #3 for each marble color (Trial #1-90) and record these values in the margin of the Student Reporting/Data Sheet next to DATA TABLE #3.
13. Using the "Your Data" values in DATA TABLE #3;
  - a) Calculate the observed ratio of outcomes (as a decimal fraction that is rounded to the 1/100<sup>th</sup> place) in which you drew marble Color #1 during Trial #1-10, recording this value in the first column of the first line of DATA TABLE #4.
  - b) Calculate the observed ratio of outcomes (as a decimal fraction that is rounded to the 1/100<sup>th</sup> place) in which you drew marble Color #2 during Trial #1-10, recording this value in the first column of the first line of DATA TABLE #4.
  - c) Calculate the observed ratio of outcomes (as a decimal fraction that is rounded to the 1/100<sup>th</sup> place) in which you drew marble Color #3 during Trial #1-10, recording this value in the first column of the first line of DATA TABLE #4.
  - d) Repeat the above steps using the data for Trial #11-20, recording the observed ratios (as a decimal fraction that is rounded to the 1/100<sup>th</sup> place) in the appropriate column of the second line of DATA TABLE #4.
  - e) Repeat steps A - C using the data for Trial #21-30, recording the observed ratios (as a decimal fraction that is rounded to the 1/100<sup>th</sup> place) in the appropriate column of the second line of DATA TABLE #4.
  - f) Repeat steps A - C using the "Total" data (Trial #1-30), recording the observed ratios in the appropriate column of the fourth line of DATA TABLE #4.
14. Repeat step 13, first using the data from Classmate #1, and then using the data from Classmate #2.
15. Using the sums that you determined in step 12, calculate the observed ratio of outcomes (as a decimal fraction that is rounded to the 1/100<sup>th</sup> place) in which you drew each marble color, recording these values on the last line in DATA TABLE #4.

## PART 2

The goal of this part of the activity is to extend your understanding of the properties of random chance events and to use these properties to understand how the elemental differences among the planets might have arisen, even though they may have been formed from a uniform mixture of elements in the post-solar nebula.

### Instructions

1. Use the mixture of marbles that you produced in Part 1 of this activity.
2. You and your partner (or the class) discuss the following:
  - a) How can a random sample be taken from the mixture of marbles using a measuring cup?
  - b) What criteria will you use for determining whether or not the measuring cup is full of marbles?
3. Using a 1/3 cup-measuring cup and the random sampling method you have decided upon, scoop the measuring cup through the mixture of marbles.
4. Empty the contents of the measuring cup into a separate bowl. One partner should count the number of marbles in each color category, while the other partner records the results in the first line of DATA TABLE #5.
5. Return the marbles to the mixing bowl and stir them thoroughly.
6. Repeat steps 3, 4, and 5 four more times, entering the results on the appropriate lines in DATA TABLE #5.
7. Complete DATA TABLE #5 by calculating and recording:
  - a) The sum of all observations.
  - b) The observed ratio (as a decimal fraction) of the three marble colors.
8. Repeat Steps 3 - 7 using a 1/2 cup-measuring cup, recording the results in DATA TABLE #6.
9. Repeat Steps 3 - 7 using a 1-cup-measuring cup, recording the results in DATA TABLE #7.

